REMARKS

Claims 1, 7, 9, 16, 17, 19 and 22 have been amended. Claims 20 and 21 have been cancelled. No new matter is being introduced by the current amendment.

Upon entry of this amendment, claims 1-3, 5-7, 9-19, and 22 will be pending.

Applicants have amended the claims solely for the purpose of expediting prosecution. Applicants reserve the right to pursue cancelled subject matter in one or more later filed continuing applications.

Rejections Under 35 U.S.C. §103

As amended, claim 1 is directed to a process for the diesterification of maleic acid by reaction of maleic acid with methanol in the presence of water of solution. The process comprises:

(a) providing a solution comprising maleic acid and the water of solution;

(b) reacting the solution of maleic acid in an esterification zone with methanol to form dimethyl maleate and water of esterification; said esterification being conducted at temperatures of from 65 to 150°C and pressures from 1 to 5 bar in a two-stage process;

(c) removing the water of solution and the water of esterification; and

(d) recovering the dimethyl maleate.

Mims

Applicants respectfully request reconsideration of the rejection of claims 1-3, 5, 6, 9-15 and 20 under 35 U.S.C. §103(a) as unpatentable over U.S. Patent No. 4,058,555 (Mims).

Mims discloses a process for the separation and recovery of components contained in a reactor effluent resulting from the air oxidation of cyclohexane. The reactor effluent contains one or more saturated dicarboxylic acids such as succinic acid. In example 1 of Mims, succinic acid along with the other reactor effluent components are introduced with equal parts methanol to an esterification reactor. Succinic acid reacts with methanol to form monomethyl succinate and dimethyl succinate. Thereafter the reactor product is introduced to a packed column, wherein benzene is used to extract the reactor products including monomethyl succinate and dimethyl succinate.

As amended, claim 1 of the instant application is directed to the diesterification of maleic acid with methanol. Nowhere does Mims contain any disclosure regarding the diesterification of maleic acid. Moreover, one skilled in the art would understand that disclosure relating to a process involving the diesterification of succinic acid or other saturated dicarboxylic acids with methanol cannot be readily applied to a process involving the diesterification of maleic acid with methanol. An important difference is that maleic acid contains a carbon-carbon double bond which allows maleate species to isomerize to fumarate species. Methyl fumarates have substantially higher melting points than maleates or succinates, as shown in the table below.

Compound	**Melting Point (°C)**
Monomethyl fumarate	144-145
Dimethyl fumarate	102-105
Monomethyl maleate	64-69
Dimethyl maleate	-17
Monomethyl succinate	56-59

Dimethyl succinate	19.5

When maleic acid is reacted with methanol, the methyl maleate species can isomerize to fumarate species, which can result in undesirable deposition of solid fumarate species within a reactor vessel, especially at operating temperatures near or below the melting point of the methyl fumarate species. Also, in some cases, fumaric acid may be present as an impurity in maleic acid feedstock. Consequently, esterification of such a feedstock with methanol can also lead to formation of methyl fumarate species along with potential for deposition of those species.

The presence of high melting point fumarate species and the associated solid deposition are problems not present in the diesterification process described in Mims. Accordingly, one skilled in the art would understand that the disclosure in Mims regarding the esterification of succinic acid or other saturated dicarboxylic acids cannot be readily applied to a process for the diesterification of maleic acid with methanol. Moreover, one skilled in the art attempting to modify the process in Mims for the diesterification of maleic acid instead of succinic acid or other saturated dicarboxylic acids would not have arrived at the claimed invention, especially in light of the abovementioned problems.

Therefore, it is respectfully submitted that claim 1 as amended is patentable over the disclosure in Mims. It is further respectfully submitted that claims 2, 3, 5, 6, and 9-15 that depend directly or indirectly from claim 1 are likewise patentable over this reference for the reasons set forth above regarding claim 1 and for the additional limitations which they introduce.

Cooley et al., Turner et al. and Mims

Applicants respectfully request reconsideration of the rejection of claims 1-3, 5, 10-12, and 16-21 under 35 U.S.C. §103(a) as unpatentable over U.S. Patent No. 4,032,458 (Cooley et al.) in view of U.S. Patent No. 4,751,334 (Turner et al.) and further in view of Mims.

Cooley et al. disclose a process for preparation of 1,4-butanediol that includes preparation of a dialkyl ester of maleic acid by reacting maleic acid with a monohydric alcohol having from 2 to about 10 carbon atoms.

The Office maintains that the operating pressures and temperatures of the claimed invention are a mere optimization even though they contravene the trends disclosed in Cooley et al.

Applicants respectfully submit that the claimed operating pressures and temperatures are much more than a mere optimization, but in fact a narrow range of conditions that surprisingly limit isomerization of methyl maleate species such that methyl fumarate species are not produced at a rate that leads to substantial deposition as a solid within the reactor vessel(s).

Nowhere do Cooley et al. disclose the combination of using methanol as the monohydric esterification alcohol at operating temperatures from 65 to 150°C and pressures from 1 to 5 bar as required by claim 1. In fact, Cooley et al. disclose that the necessary operating pressure will be highest whenever the monohydric alcohol is ethanol and will decrease as the molecular weight of the monohydric alcohol increases. Cooley et al. further describe the preferred embodiment as employing n-butanol (a C-4 monohydric alcohol) as the monohydric alcohol and

operating the reactor column at a pressure between about 55 to 80 psig (3.8-5.15 bar) to maintain a temperature from about 175°C to about 235°C. Accordingly, one skilled in the art having knowledge of the above-described problems with the esterification of maleic acid with methanol would follow the pressure trend taught by Cooley et al. and expect that a higher operating pressure (in excess of 3.8-5.15 bar) would be required to maintain a high temperature in the column (in excess of 175°C to 235°C) and to avoid undesirable deposition of solid methyl fumarate species within the reactor column. Applicants, working contrary to the teachings in Cooley et al. and despite the above-described problem resulting from the high melting temperature of methyl fumarate species, have unexpectedly discovered that a narrow range of lower operating pressures (1 to 5 bar) and temperatures (65 to 150°C) can be used for the diesterification of maleic acid with methanol and thereby limit the formation and deposition of solid methyl fumarate species within the reactor vessel(s).

In addition, Cooley et al. unequivocally teach away from the use of methanol as the monohydric alcohol for the diesterification of maleic acid as required in claim 1 as amended. The Office maintains that Cooley et al. do not exclude methanol as the monohydric esterification alcohol from their invention and thus it is obvious to use any monohydric alcohol, including methanol. As the basis for its argument, the Office relies solely on the use of the term "include" in the following statement from Cooley et al. at column 2, lines 46-49:

> The monohydric alcohols which are suitable in the practice of the process of this invention include monohydric alcohols having from 2 to about 10 carbon atoms.

Applicants agree that in general the term "include" is an open-ended term. However, applicants disagree that inclusion of such term preceding the stated range of suitable monohydric alcohols renders the use of all other monohydric alcohols obvious. Moreover, the Office has seemingly ignored other, more concrete disclosure in Cooley et al. that teaches away from using methanol as the monohydric alcohol, such as the following:

1) Cooley et al. use precise language within the specification to recite that suitable monohydric alcohols include alcohols having from 2 to about 10 carbon atoms. In describing their invention, Cooley et al. have deliberately excluded the term "about" preceding the "2" while including it preceding the "10."

2) Cooley et al. use precise, limiting language within claim 1 that recites a "monohydric alkanol having from 2 to about 10 carbon atoms." In defining their invention in claim 1, Cooley et al. have deliberately excluded the term "about" preceding the "2" while including it preceding the "10." Moreover, Cooley et al. do not use open-ended language such as "include" or "comprise" with this range in claim 1.

3) Cooley et al. state that "preferred monohydric alcohols are those which form heterogeneous azeotropes with water." Cooley et al. list n-butanol, primary isoamyl alcohol and n-amyl alcohol as suitable monohydric, azeotrope-forming alcohols (See, col. 2, lines 46-57).

Applicants submit that one skilled in the art considering the reference as a whole and the above-enumerated disclosure in particular, would understand that Cooley et al. teach away from the use of methanol as the monohydric esterification alcohol.

Moreover, one skilled in the art considering (1) the potential for undesirable deposition of solid methyl fumarate

species when using methanol as the monohydric esterification alcohol, especially at temperatures below the melting point of methyl fumarates, (2) the pressure trend in Cooley et al. that provides that the necessary operating pressure will be highest for ethanol and will decrease as the molecular weight of the monohydric alcohol increases, and (3) the disclosure in Cooley et al. enumerated above that further teaches away from using methanol as the monohydric esterification alcohol, would not find it obvious to use methanol as the monohydric esterification alcohol at operating temperatures of from 65 to 150°C and pressures from 1 to 5 bar as required by claim 1.

The Office relies on Mims to substantiate the use of methanol as the monohydric esterification alcohol. However, as amended, claim 1 is directed to the diesterification of maleic acid with methanol. Nowhere does Mims contain any disclosure regarding the diesterification of maleic acid. Moreover, for the reasons described above in the argument over the rejection based on Mims, one skilled in the art would understand that disclosure relating to a process involving the diesterification of succinic acid or other saturated dicarboxylic acids with methanol cannot be readily applied to a process involving the diesterification of maleic acid with methanol. Therefore, applicants submit that the disclosure in Mims does not cure the deficiencies of Cooley et al.

Turner et al. disclose preparation of 1,4-butanediol by the vapor phase hydrogenolysis of an alkyl ester of a C_4 dicarboxylic acid utilizing a reduced copper-chromium or copper-zinc mixed oxide catalyst. Nowhere do Turner et al. disclose utilizing methanol for preparation of the alkyl ester of the dicarboxylic acid. The only mention of methanol is in connection with dilution of the ester to provide the dehydrogenation feedstock

(See, for example, col. 4, lines 61-63). Accordingly, the disclosure of Turner et al. does not cure the deficiencies of the primary reference and the combination of references relied on by the Office fails to establish a *prima facie* case of obviousness with respect to the process of claim 1 as amended.

In view of the above, it is respectfully submitted that claim 1 is patentable over the disclosure of Cooley et al. in view of the disclosure of Turner et al. and in further view of Mims. It is further respectfully submitted that claims 2, 3, 5, 10-12, and 16-19 that depend directly or indirectly from claim 1 are likewise patentable over this combination of references for the reasons set forth above regarding claim 1 and for the additional limitations which they introduce.

Schwartz et al., Cockrem et al., and Mims

Applicants respectfully request reconsideration of the rejection of claims 1, 2, 5-7, 9-15, and 20-22 under 35 U.S.C. §103(a) as unpatentable over GB 1,437,898 (Schwartz et al.) in view of U.S. Patent No. 5,210,296 (Cockrem et al.) and Mims.

Schwartz et al. disclose a process for the preparation of maleic acid esters that comprises reacting maleic acid with a monohydric alcohol. Schwartz et al. generally disclose a wide array of primary, secondary and tertiary monohydric alcohols having from one to 18 carbon atoms that may be employed and an equally expansive range of esterification operating conditions.

Like Cooley et al., Schwartz et al. fail to disclose the combination of using methanol as the monohydric esterification alcohol at operating temperatures of from 65 to 150°C and pressures from 1 to 5 bar as required by claim 1 of the present invention. As described above, applicants claimed operating pressures and temperatures are much more than a mere

optimization, but in fact a narrow range of conditions that surprisingly limit isomerization of methyl maleate species such that methyl fumarate species are not produced at a rate that leads to substantial deposition as a solid within the reactor vessel(s). Applicants invite the Office to cite the passage(s) of Schwartz et al. that would direct one skilled in the art to arrive at the claimed combination.

Moreover, like Cooley et al., Schwartz et al. teach away from using methanol as the monohydric esterification alcohol. Schwartz et al. state that the C_4 to C_{18} (more preferably C_4 to C_8) primary alcohols are preferred (See, for example, page 2, lines 102-107 and page 3, lines 9-23 and lines 48-63) and only provide working examples for n-butanol (C_4) and n-hexanol (C_6). Schwartz et al. state that preferred alcohols will not be completely soluble with water and will have a boiling point from 100 to 200° C (See, for example, page 2, lines 110-111 and lines 119-121). By contrast, methanol is fully miscible with water and has a boiling point of about 65° C.

Also, applicants maintain that the teaching away from using methanol as the monohydric esterification alcohol in Schwartz et al. is reinforced by considering the reference in view of Cooley et al.[1] Cooley et al. is related to the disclosure of Schwartz et al. since both references cover nearly the same subject matter, Stone D. Cooley is a common inventor in both, and both of the references are assigned to the same entity (Petro-Tex Chemical Corporation). Moreover, the application that issued as GB 1,437,8928 (Schwartz et al.) was filed December 5, 1974, while the application that issued as U.S. Patent No. 4,032,458

[1] The Office must consider the disclosure of Schwartz et al. with due regard to all of the relevant teachings in the prior art. See *In re Kuderna and Phillips* 426 F.2d 385, 165 USPQ 575 (C.C.P.A. 1970). Further, MPEP 2145 states that "[t]he totality of prior art must be considered, and proceeding contrary to accepted wisdom in the art is evidence of nonobviousness.

(Cooley et al.) was filed later on August 8, 1975. One skilled in the art considering the relevant teachings from Cooley et al. and Schwartz et al. would find that initially Schwartz et al. disclosed that the monohydric alcohols that may be employed are generally primary, secondary, and tertiary alcohols having from one to 18 carbon atoms. Later, this range was specifically limited the monohydric alcohols to those containing "from 2 to about 10 carbon atoms" in the disclosure of Cooley et al. Therefore, one skilled in the art considering the sum of the teaching of these two references would conclude that the exclusion of methanol from the later-filed Cooley et al. reference as indicating that methanol was not a suitable monohydric alcohol for use in the esterification process.

Again, the Office relies on Mims to substantiate the use of methanol as the monohydric esterification alcohol. However, as amended, claim 1 is directed to the diesterification of maleic acid with methanol. Nowhere does Mims contain any disclosure regarding the diesterification of maleic acid. Moreover, for the reasons described above in the argument over the rejection based on Mims, one skilled in the art understands that disclosure relating to a process involving the diesterification of succinic acid other saturated dicarboxylic acids with methanol cannot be readily applied to a process involving the diesterification of maleic acid. Therefore, applicants submit that the disclosure in Mims cannot cure the deficiencies of Schwartz et al.

Cockrem et al. discloses a process for recovery of lactate ester or lactic acid that comprises esterifying lactic acid (i.e., a C_3 monocarboxylic acid) with an alcohol containing 4 to 5 carbon atoms (See, for example col. 5, lines 32-35 of Cockrem et al.). Cockrem et al. fail to disclose the reaction of a

dicarboxylic acid with methanol under any conditions. It is respectfully submitted that the this reference also fail to cure the deficiencies of the primary reference and the combination of references relied on by the Office fails to establish a *prima facie* case of obviousness as to claim 1.

In view of the above, it is respectfully submitted that claim 1 is patentable over the disclosure of Schwartz et al. in view of the disclosure of Cockrem et al. and Mims. It is further respectfully submitted that claims 2, 5-7, 9-15, and 22 that depend directly or indirectly from claim 1 are not obvious in view of this combination of references for the reasons set forth above regarding claim 1 and the additional limitations which they introduce.

Favorable reconsideration and allowance of all pending claims are respectfully requested.

The Commissioner is hereby authorized to charge any fee deficiency or underpayment in connection with this Amendment to Deposit Account No. 19-1345.

Respectfully submitted,

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